

# Monetary valuation of rare species and imperiled habitats as a basis for economically evaluating conservation approaches

**Richard M. Engeman**  
National Wildlife Research  
Center  
4101 LaPorte Ave  
Fort Collins, CO 80521-2154  
richard.m.engeman@aphis.usda.gov

**Stephanie A. Shwiff**  
National Wildlife Research  
Center  
4101 LaPorte Ave  
Fort Collins, CO 80521-2154  
stephanie.a.shwiff@aphis.usda.gov

**Henry T. Smith**  
Florida Department of  
Environmental Protection  
Florida Park Service, 13798 S.E.  
Federal Highway, Hobe Sound  
FL 33455  
hank.smith@dep.state.fl.us

**Bernice Constantin**  
USDA/APHIS/WS  
2820 East University Ave.  
Gainesville, FL 32641  
bernice.u.constantin@aphis.usda.gov

## Abstract

Management actions directed towards the conservation of species or habitats are usually measured in resource improvement. Nevertheless, the decision to select and carry out such actions are rooted in the available funding. Therefore, to truly evaluate the benefit-costs of a conservation-directed management action, the resource improvement should be in the same metric as the expenditures. To this end, we describe here a variety of methods for attaching monetary values to rare species and habitats. We also give examples of applications with which we have been involved to demonstrate how such species and habitat valuations have allowed economic analyses of conservation approaches. The economic results helps to decide on how best to obtain the most from finite funding resources.

## Resumen

Las acciones de manejo dirigidas a la conservación de especies o hábitat normalmente se miden con base en el mejoramiento de recursos. Sin embargo, las decisiones para elegir y ejecutar estas acciones están basadas en la disponibilidad de fondos. En consecuencia, para evaluar realmente el costo - beneficio de una acción de manejo para la conservación, el mejoramiento del recurso debe ser medido de la misma manera que los gastos. Con este fin, describimos una variedad de métodos para atribuir valores monetarios a especies y hábitats únicos. También, damos ejemplos de las aplicaciones que hemos usado para demostrar como estas evaluaciones de especies y hábitats permiten el análisis económico de los métodos para la conservación. Los análisis económicos ayudan a decidir la mejor manera de aprovechar los fondos disponibles.

## Introduction

Many endangered, threatened, or other species of special concern and their habitats, require management actions to aid their recovery. Funding is finite for recovery and conservation of species and habitats and must be carefully applied to maximize the positive impact on the protected resource. Analytical examination of the economics of management actions for resource (species or habitat) enhancement can provide managers with a logical working basis for selecting and implementing the most cost-effective conservation methodologies. While the direct costs for a conservation approach may be relatively easy to identify and quantify because they can be measured by the budgetary outlay for implementation, the rewards from those budgetary allocations are measured in terms of resource improvements, such as population growth or habitat recovery. To effectively evaluate the returns, the rewards from the expenditures must be in the same metric as the expenditures. That is, the resource improvement must also be monetarily valued. We describe some approaches that we have applied for monetarily valuing rare wildlife and habitat resources, and we review some of the conservation applications with which we have been involved.

## Monetary Valuation of Rare Species

Determination of monetary values for rare species is not a straight-forward nor precise process. As an illustration, consider that values of endangered or threatened species have been deemed "incalculable" in U.S. Supreme Court case law (*Tennessee Valley Authority vs. Hill* 1978), the opinion going so far as to say "it would be difficult for a court to balance the loss of a sum certain - even \$100 million - against a congressionally declared 'incalculable' value, even assuming we had the power to engage in such a weighing process, which we emphatically do not." Despite that assessment, infinite or astronomically high monetary species valuations would be unlikely to be widely viewed as credible. Conservative and

credible monetary values for rare species can be estimated through the variety of means that follow.

*Contingent valuation* is one method by which a value is assigned to a resource. Contingent valuation intends to measure people's willingness to pay (WTP) for resources in a hypothetical market through the use of a survey instrument (e.g., Loomis and Walsh 1997). The respondent is asked to estimate the maximum amount he would pay to have a resource available. The payment method can be adjusted to fit the resource in question; examples include higher prices for natural area entrance fees or hunting and fishing licenses, higher trip costs, and taxes. WTP often varies greatly between payment methods. Question format can have a large influence on the results. Common formats include open-ended questions, payment cards, iterative bidding, and dichotomous choice and referenda (Loomis and Walsh 1997). Because the scenarios are hypothetical, the validity of the responses to a contingent valuation is unsure, and the results may not reflect the true WTP, either because people do not have a realistic sense of how much they would pay, or because they have incentives to dishonestly report their WTP (Loomis and Walsh 1997). To use contingent valuations of rare species in an economic analysis first requires that such survey values exist or can be generated, and that the data were obtained using statistically valid survey design principles, data collection procedures, and data analyses. Given the above, the results must be geographically and temporally relevant to the economic analyses at hand.

*Legislatively designated values* are another useful method for assigning societal values to resources (Engeman et al. in press; Bodenchuk et al. 2002). State wildlife and fisheries management agencies use estimates of economic values based on contributions to the economy by individual game species to derive their monetary values (Bodenchuk et al. 2002). These economic values serve as the basis for civil financial penalties for illegal kills re-

sulting from such acts as poaching, environmental contamination, or other "takes" (Bodenchuk et al. 2002). However, rare and endangered species do not have civil financial penalties assigned in relation to their contributions to the economy as "renewable" resources, because they are rarely, if ever, exploited in a financially measurable fashion such as through the sale of hunting or fishing licenses and sportsman equipment.

While not exploited in an easily quantifiable sense, rare and endangered species are, however, almost universally protected with civil penalties set forth legislatively. More than likely, such species will have more than one value available from multiple enabling legislations (e.g., United States federal and individual state laws). Multiple applicable civil penalties pose a dilemma as to which to incorporate into an economic analysis. A conservative benefit-cost analysis is obtained when the minimal applicable value is employed. However, this could be a radical undervaluation for a species, especially when considering that all civil financial penalties from the different enabling legislations can apply simultaneously. Consider the example of predator depredations on marine turtle nests in Florida by Engeman et al. (2002). Their analyses chose the conservative route of applying a minimum legislative value of \$100 from Florida statutes. However, the Florida Wildlife Code specified a value of \$500 per life unit, and the federal Endangered Species Act (ESA) allows for civil penalties up to \$25,000 per life unit. Thus, the monetary benefits accrued from the predator management approaches could have been as much as 250 times greater.

*Breeding costs* provide an empirical measure of value for a species. Captive breeding is not only a management strategy for assisting the recovery of rare species, but it also provides data for placing a value on a species. The use of captive breeding costs as a means for monetarily valuing rare species is a simple concept, because those monies spent to produce animals in captivity

are empirically explicit demonstrations of a willingness to pay for new animals. The costs of captive breeding divided by the number of healthy individuals produced defines a value for the species (e.g., Bodenchuk et al. 2002). For example, the value calculated for black-footed ferret production (*Mustela nigripes*) in 1995 in this manner was \$29,132 per animal (Bodenchuk et al. 2002). However, the valuing process is not quite as straight-forward as this seems. Sometimes, there are multiple captive breeding facilities for the same species, each with its own budget (e.g., Engeman et al. 2003b). A facility may remain in operation year-in and year-out, but its temporal budget and animal production may fluctuate substantially. Thus, budget and production variation among captive breeding sites for a particular species, and among years within a site, can result in substantial variation in the value for a particular species. The selection of a particular value for a benefit-cost or net benefit analysis must be carefully weighed against the objectives of the analysis. The most conservative analysis is obtained if the minimum cost per production of a healthy individual is used, whereas use of the maximum value provides the empirical peak expenditure to produce an individual of the species. Use of the median value for an individual provides an analysis representing the central tendency for valuing the species.

#### Monetary Valuation of Special Habitats

As with valuing rare species, credible valuation of special habitats is not straightforward. Special habitats such as wetlands have limited market value, and if such habitat is selectively protected, the market value diminishes further (King 1998). The use of contingent valuation surveys for special habitats, analogous to those applied to endangered animals is always a possibility, but they tend to be even more abstract appraisals of value (King 1998). Realistic cost estimates for restoring habitat to pristine condition (replacement costs) frequently are well in excess of the public's willing-

ness-to-pay, and therefore, also do not represent a realistic valuation of wildlands. A defensible, logical, and applicable valuation for damaged habitat is to use expenditure data for permitted mitigation projects. Such data represent an empirical demonstration of willingness-to-pay value, and are most generally available for wetland habitats. The US dollar amounts per unit area spent in efforts to restore the various wetland habitat types has been presented by King (1998). The numbers represent the U.S. dollar amounts that environmental regulators, and to a degree elected governments, have allowed permit applicants to spend in attempts to replace lost wetland services and values (King 1998). Use of these figures, coupled with appropriate adjustments for annual rates of inflation (Zerbe and Dively 1994) leads to credible habitat valuations.

### Example applications

#### *Benefit-cost analyses of predator removal approaches for reducing losses of sea turtle nests*

Historically, up to 95% of sea turtle nests at Hobe Sound National Wildlife Refuge (HSNWR), Florida have been destroyed by predation. In response, predator removal has been carried out since 1972 and was identified in a comprehensive Environmental Assessment (U.S. Fish and Wildlife Service 2000) as the only practical and legal approach for reducing nest predation on marine turtle nests at HSNWR by raccoons (*Procyon lotor*) and armadillos (*Dasypus novemcinctus*), and it is most important management program at the refuge (Bain et al. 1997). Over time, four approaches to predator removal had been applied that ranged from no removal to a predator removal contract with USDA/Wildlife Services coupled with predator monitoring using a passive tracking index (Engeman et al. 2003a). A benefit-cost analysis was conducted to compare the relative benefits of each predator removal approaches to its cost, and to each of the other approaches. Turtle reproductive data and predation data under each predator removal scenario were available and allowed estimation of the number of hatchlings that would have been lost to



Photo courtesy of Richard Engeman

predation under each scenario. Predator management costs were known, therefore monetary values for hatchling sea turtles would allow the appropriate benefit-cost analyses to be conducted.

Contingent valuation and legislative values were the options considered for placing a value on hatchlings. Breeding costs for the sea turtle species nesting at HSNWR were not available. Whitehead (1992) in a contingent valuation survey had previously appraised marine turtle values at \$32, however Engeman et al. (2003a) found those values to be inappropriate to generalize to the HSNWR situation due to severe survey design limitations in terms of the maximum monetary values that turtles could obtain, and use of those results would have been an extrapolation beyond the inference space of the data, both geographically and temporally. The survey was a small sample from North Carolina, whereas the Engeman et al. (2003a) study was in east-central Florida. In particular, the city bordering the Florida refuge, Jupiter Island, was considered the wealthiest in the U.S. (Nguyen 2000), thus making it unlikely that its residents would value turtles as low as in the Whitehead (1992) survey. Furthermore, the Whitehead (1992) results were approximately a decade earlier than the Engeman et al. (2002) economic analysis, making them temporally as well as geographically disjunct from the situation at hand. This exercise proved valuable as a cautionary lesson concerning the use of

Figure 1. The Puerto Rican parrot (*Amazona vittata*)

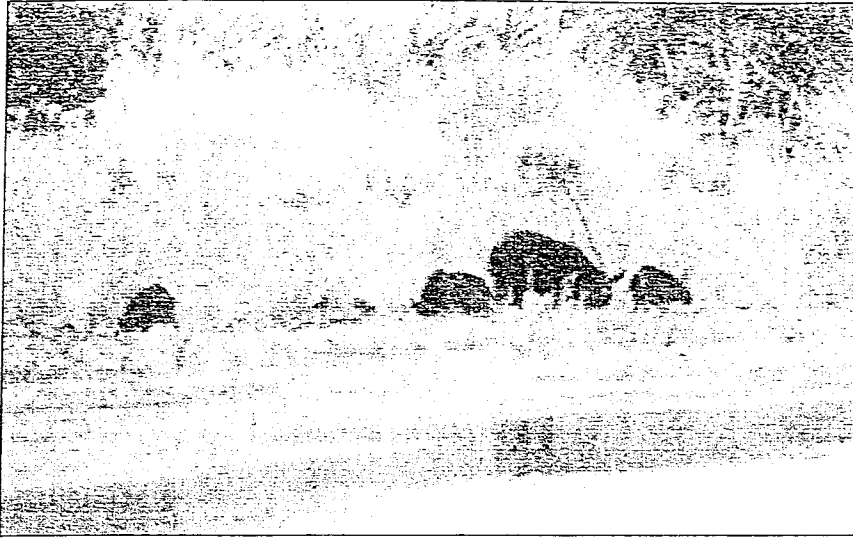


Figure 2. Feral swine (*Sus scrofa*) foraging and damaging valuable habitat.

contingent valuations and led us (as already described) to apply a conservative, legislatively designated value of \$100 from the Florida statutes, although higher values from other enabling legislations could have been used. Even so, the removal contract with USDA/Wildlife Services coupled with predator monitoring was found to have the highest benefit cost ratio, with a \$5,000 contract resulting in conservatively estimated savings of \$8.4 million in hatchling sea turtles (Engeman et al. 2002).

#### *Hypothetical benefit-cost ratios for managing predators that threaten Puerto Rican parrots*

The Puerto Rican parrot (*Amazona vittata*) (Figure 1) is one of the 10 most endangered birds in the world (U.S. Fish and Wildlife Service 1999), with only 30-40 birds comprising the single wild population. As with many endangered or locally rare species (Hecht and Nickerson 1999), predation has been identified as one of the factors limiting Puerto Rican parrot productivity in the wild (Snyder et al. 1987; Lindsey et al. 1994; U.S. Fish and Wildlife Service 1999). Parrot recovery efforts require many high-cost expenditures such as captive breeding, but the economic benefit from expenditures on predator management had not been analyzed.

To address this issue, we conducted an economic analysis of predator management for protecting Puerto Rican parrots (Engeman et al. 2003b). Five years of data on the production costs and the corresponding number of

healthy fledglings produced from three highly managed populations (the wild and the two captive populations) were used to value Puerto Rican parrots. Resulting parrot valuations over years and populations ranged from \$2,415 to \$100,000 per individual. The median annual value from combining the expenditures each year for the three populations was \$25,500 per parrot. Predator management costs were estimated from existing U.S. Department of Agriculture/Wildlife Services contracts for similar work in Puerto Rico. If median parrot values were applied, then only one parrot would have to be saved from predation every 2.6 years to allow the combined management for all predator species to be cost-effective. If the year of maximal parrot values (averaged over captive and wild populations) was used, then only one parrot saved every 4.2 years would make application of all predator management methods cost-effective. Use of the single highest per-parrot value from among years and populations would result in the combined application of all forms of predator management being cost-effective if only one parrot is preserved from predation every 11.8 years. Subsequently, predator management is now viewed as a component of the parrot recovery process that is unaffordable to omit.

#### *Economically evaluating a structural method for reducing road kills of royal terns at bridges*

Royal terns (*Sterna maxima*) in Florida are listed as a "species of special concern" by the Florida Committee on Rare and Endangered Plants and Animals (Egensteiner et al. 1996). Collisions with vehicles cause many royal tern road-kills at some coastal roads and bridges in Florida (Skoog 1982; Smith et al. 1994; Bard et al. 2002b). We examined the benefit-costs to royal tern conservation from a multi-year trial of a simple hazard reduction method applied to a bridge in east-central Florida (Shwiff et al. 2003), whereby metal poles were fastened vertically on both sides of the bridge to reduce the num-

ber of collisions between vehicles and birds by influencing them to fly well over bridge traffic (Bard et al. 2002a).

The benefit-cost analysis (BCA) of the structural modification involved estimating the monetary value of the benefits, measured in terns saved by reduced road-kills at bridge sites, versus the costs of making structural (i.e., erecting poles) modifications. Legislatively designated values from the Wildlife Code of the State of Florida (Chapter 39 F.A.C.) that specify up to a \$500 fine for "take" were applied for a conservative analysis, and the U.S. Migratory Bird Treaty Act (16 U.S.C. 703-711), which specifies up to a \$2,000 fine for "take" of any migratory bird, provided an upper range on tern values. The initial expenditure of \$5,900 to erect the poles provided protection for 5 years (1995-1999). The five full years of protection cost an average of \$1,180/yr. The average number of road-killed royal terns during this same period was 5.2 terns/yr, which was 14.2 terns/yr less than the average of 19.4 terns/yr for the 5 years before erection of the poles. Using the \$500 per tern value, the average loss values before and after the structural modification program were \$48,500 and \$13,000. The corresponding values using the \$2,000 per tern value were \$194,000 and \$52,000. The average of 14.2 terns/year saved with a value of \$500 per tern produced an average annual savings of \$7,100. Over the 5 year period, the structural modifications provided a cumulative annual rate of return on the initial \$5,900 investment that increased from 20 % after year 1 to 502 % after five years.

#### *Valuing Florida wetland habitat lost to feral swine damage*

We carried out studies in two wetland habitat types in Florida whereby we estimated the amount and value of the habitat damaged through rooting by feral swine (*Sus scrofa*) (Figure 2). First, we monitored swine damage to native wet pine-flatwoods at three state parks from winter 2002 to winter 2003 (Engeman et al. 2003d). We also estimated the amount and value of swine damage to the last remnant of a formerly extensive basin marsh system now located only in Sa-

vannas Preserve State Park (Engeman et al. 2003c). While different sampling approaches were required to estimate damage in the different habitats, we used the same concept for attaching unit-area economic values to the habitat damage. For each study, we identified the dollar value for the appropriate wetland habitat category from each of the two studies in King (1998). The cost-per-unit area of swine damage in each case was calculated by multiplying the estimated proportion of area damaged by swine by the cost-per-unit area for habitat restoration.

The three parks where we examined damage to wet pine-flatwoods had different swine management histories and the damage patterns differed among them over time. The park in which swine were intensively removed in 2000 initially had the lowest habitat damage at 1.3%, but as a result of natural and artificial population growth it rose to 5.4% by the conclusion of the study, and was valued at \$19,193-36,498/ha. A park with no history of swine harvest had damage escalate from 2.6% to 6.4%, with an associated value of \$22,747-43,257/ha. Swine were managed as game animals in the third park prior to its inclusion into the state park system in 2000. Its proportion of area damaged decreased from 4.3% to 1.5%, valued at \$5,331 - \$10,138/ha. We attributed this decrease to human activities associated with development of the park's infrastructure causing dispersal of animals conditioned to avoid humans by hunting. Damage was highly scattered in each park, as evidenced by a much higher proportion of sampling sites showing damage than the actual proportion of land area damaged. The dispersed nature of small amounts of damage would tend to increase the effort for recovering habitat and make damage value estimates more conservative. Damage valuation estimates also were conservative because it was impossible to incorporate values for such contingencies as swine impact to state and federally listed endangered plants in the parks, some of which are found nowhere else in the world.

We found that swine damaged 19% of the exposed portion of the basin marsh in our study area. Seventy percent of the sample sites showed swine damage at the shoreline ecotone and 58% showed damage at the upland ecotone. The area damaged within our study site alone was valued between \$1,238,760 and \$4,036,290. In estimating the monetary values of the swine damage to the habitat we assumed standard costs for restoration. The periphery of the entire basin marsh would be about five times our study site. The cost of this contract was \$7,500, and represents only a minor fraction of the value of the swine damage to an average single ha of the exposed basin marsh, let alone to the synergistic value of the swine damage.

*Benefit costs of removing feral cats to protect Key Largo wood rats*

Worldwide, feral cats (*Felis catus*) are well-known to be highly destructive predators of native species. We are currently in the initial phases of data collection in Key Largo, Florida to document efficacy of feral cat removal efforts for protecting the highly endangered Key Largo woodrat (*Neotoma floridana smalli*). A companion component to the efficacy assessment will be to economically assess the cat removal efforts in terms of the dollar value of its impacts to the woodrat population. To do this, Key Largo woodrats will require valuation. Options for this include state and federal legislative values as for the sea turtle and royal tern examples, or if available, captive breeding costs from a breeding program now in its infancy. In this manner, the benefit-costs of feral cat removal as a Key Largo woodrat conservation tool can be valued.

**Summary**

The ability to value rare wildlife or sensitive habitat resources provides a necessary and effectual tool for evaluating conservation approaches. Economic information and analyses can greatly assist managers on how most efficiently and effectively to allocate limited funds towards species conservation. Ulti-

mately, many conservation funding decisions are made on a political level by people without high levels of training or expertise in biological sciences. Placing conservation issues in an economic context can greatly enlighten the political decision making process in an increasing economic arena.

**Literature cited**

- Bain, R.E., S.D. Jewell, J. Schwagerl and B.S. Neely Jr. 1997. Sea turtle nesting and reproductive success at the Hobe Sound National Wildlife Refuge (Florida), 1972-1995. Report to U.S. Fish and Wildlife Service, ARM Loxahatchee NWR.
- Bard, A.M., H.T. Smith, E.D. Egensteiner, R. Mulholland, T.V. Harber, G.W. Heath, W.J.B. Miller and J.S. Weske. 2002a. A simple structural method to reduce road-kills of Royal Terns at bridge sites. *Wildlife Society Bulletin*. 30:603-605.
- Bard, A.M., H.T. Smith, T.V. Harber, G.W. Stewart, J.S. Weske, M.M. Browne and S.T. Emslie. 2002b. Road-killed Royal Terns (*Sterna maxima*) recovered at Sebastian Inlet State Park, Florida, USA: A 23-year analysis of banding data. In L.M. Terwilliger and L. Coryell (Eds), *Proceedings of the International Conference on Wildlife Ecology and Transportation*. pp 386-389.
- Bodenchuk, M.J., J.R. Mason and W.C. Pitt. 2002. Economics of predation management in relation to agriculture, wildlife, and human health and safety. In Engeman R.M., S.A. Shwiff, H.T. Smith and B. Constantin. in press. Monetary valuation methods for economic analysis of the benefit-costs of protecting rare wildlife species from predators. *Integrated Pest Management Reviews*.
- Engeman, R.M., R.E. Martin, B. Constantin, R. Noel and J. Woolard. 2003a. Monitoring predators to optimize their management for marine turtle nest protection. *Biological Conservation*. 113:171-178.
- Engeman, R.M., S.A. Shwiff, F. Cano and B. Constantin. 2003b. An economic assessment of the potential for predator management to benefit Puerto Rican parrots. *Ecological Economics*. 46:283-292.
- Engeman, R.M., S.A. Shwiff, B. Constantin, M. Stahl and H.T. Smith. 2002. An Economic Analysis of Predator Removal Approaches for Protecting Marine Turtle Nests at Hobe Sound National Wildlife Refuge. *Ecological Economics*. 42:469-478.

- Engeman, R.M., H.T. Smith, R. Severson, M.A. Severson, S.A. Shwiff, B.U. Constantin and D. Griffin. 2003c. Amount and economic value of feral hog damage to a unique basin marsh wetland in Florida. Florida Park Service, 2003 "Parknership" Technical Report. Tallahassee, FL. 5pp.
- Engeman, R.M., H.T. Smith, S.A. Shwiff, B. Constantin, M. Nelson, D. Griffin and J. Woolard. 2003d. Estimating the prevalence and economic value of feral swine damage to native habitats in three Florida state parks. *Environmental Conservation*. 30:319-324.
- Egensteiner, E.D., H.T. Smith and J.A. Rodgers, Jr. 1996. Royal Tern. In: J.A. Rodgers, Jr., H.W. Kale, II, and H.T. Smith, (Eds), *Rare and Endangered Biota of Florida*, Vol. V: Birds. pp 532-540. University Press of Florida, Gainesville, FL.
- Hecht, A. and P.R. Nickerson. 1999. The need for predator management in conservation of some vulnerable species. *Endangered Species Update*. 16:114-118.
- King, D. 1998. The dollar value of wetlands: trap set, bait taken, don't swallow. *National Wetlands Newsletter*. July-August:7-11.
- Lindsey, G.D., W.J. Arendt and J. Kalina. 1994. Survival and causes of mortality in juvenile Puerto Rican parrots. *Journal of Field Ornithology*. 65:76-82.
- Loomis, J.B., and R.G. Walsh. 1997. *Recreation Economic Decisions: Comparing Benefits and Costs*, 2nd Edition, Venture Publishing, Inc. State College, PA pp. 369 - 410.
- Nguyen, L.N. 2000. America's richest towns. *Worth Magazine*. 2000 (June):88.
- Reynolds, J.C. and S.C. Tapper. 1996. Control of mammalian predators in game management and conservation. *Mammal Review*. 26:127-156.
- Shwiff, S.A., R.M. Engeman, A.M. Bard, T.V. Harbor, G.W. Heath and H.T. Smith. 2003. An economic analysis of a simple structural method to reduce road-kills of royal terns at bridge sites. *Caribbean Journal of Science*. 39:250-253.
- Skoog, P.J. 1982. Highways and endangered wildlife in Florida; impacts and recommendations. Florida Game and Fresh Water Fish Commission, Tallahassee, Florida, USA.
- Smith, H.T., W.J.B. Miller, R.E. Roberts, C.V. Tamborski, W.W. Timmerman and J.S. Weske. 1994. Banded Royal Terns recovered at Sebastian Inlet, Florida. *Florida Field Naturalist* 22:81-83.
- Snyder, N.F.R., J.W. Wiley and C.B. Kepler. 1987. *The parrots of Luquillo: natural history and conservation of the Puerto Rican parrot*. West. Found. Vetebr. Zool. Los Angeles, CA. 384pp.
- Tennessee Valley Authority vs Hill. 1978. 437 U.S. 153.
- U.S. Fish and Wildlife Service. 1999. Technical/Agency Draft Revised Recovery Plan for the Puerto Rican Parrot (*Amazona vittata*). U.S.F.W.S. Region 4, Atlanta, GA. 77pp.
- U.S. Fish and Wildlife Service. 2000. Environmental Assessment for the Management of Predation Losses to Sea Turtle Nests at the Hobe Sound National Wildlife Refuge, Martin County, Florida.
- Whitehead, J.C., 1992. Ex ante willingness to pay with supply and demand uncertainty: implications for valuing a marine turtle protection programme, *Applied Economics*. 24:981-988.
- Zerbe, R.O. and D.D. Dively, 1994. *Benefit-Cost Analysis: In Theory and Practice*, HarperCollins College Publishers, New York, NY.

